

**What is claimed is:**

1. A method of forming droplets, the method comprising:  
5                   flowing a liquid through a channel;  
                  spreading the liquid into a thin film in the channel; and  
                  impinging the thin film with a flowing gas to atomize the liquid into droplets  
having a diameter less than 35 micrometers.
- 10                   2. A method according to claim 1 wherein the thickness of the thin film is less  
than 0.020 in.
3. A method according to claim 1 wherein the thickness of the thin film is less  
15                   than 0.005 in.
4. A method according to claim 1 wherein the liquid comprises a  
pharmaceutical active agent.
5. A method according to claim 1 further comprising contacting the thin film  
20                   with a second flowing gas.
6. A method according to claim 1 wherein the thin film is cylindrically shaped.
7. A method of forming droplets, the method comprising:  
25                   flowing a liquid through a channel;  
                  spreading the liquid into a thin film; and  
                  impinging the thin film with a flowing gas to atomize the liquid into droplets,  
the flowing gas impinging the thin film at a right angle.
- 30                   8. A method according to claim 7 wherein the thickness of the thin film is less  
than 0.020 in.

9. A method according to claim 7 wherein the thickness of the thin film is less than 0.005 in.

5 10. A method according to claim 7 wherein the liquid comprises a pharmaceutical active agent.

11. A method according to claim 7 wherein the thin film is cylindrically shaped.

10 12. A method of forming a pharmaceutical formulation, the method comprising:  
flowing a liquid through a channel, the liquid comprising a pharmaceutical  
active agent;  
spreading the liquid into a thin film;  
impinging the thin film with a flowing gas to atomize the liquid into  
droplets; and  
15 drying the droplets to form particles comprising the active agent.

13. A method according to claim 12 wherein the particles have a mass median diameter less than 20  $\mu\text{m}$ .

20 14. A method according to claim 12 wherein the particles have a mass median diameter less than 10  $\mu\text{m}$ .

15. A method according to claim 12 wherein the active agent comprises insulin.

25 16. A pharmaceutical formulation produced by a method comprising:  
flowing a liquid through a channel, the liquid comprising a pharmaceutical  
active agent;  
spreading the liquid into a thin film;  
impinging the thin film with a flowing gas to atomize the liquid into  
30 droplets; and  
drying the droplets to form particles comprising the active agent.

17. An atomizer for forming droplets, the atomizer comprising:  
a first channel through which a liquid may flow, the channel comprising a  
constriction for spreading the liquid into a thin film in the channel; and  
5 a second channel through which an atomizing gas may flow, the second  
channel being positioned so that the atomizing gas impinges the liquid thin film in a manner which  
produces droplets having a diameter less than 35 micrometers.

18. An atomizer according to claim 17 wherein the constriction has a diameter  
10 less than 0.020 in.

19. An atomizer according to claim 17 wherein the constriction has a diameter  
less than 0.005 in.

20. An atomizer according to claim 17 further comprising a third channel  
15 through which a gas may flow.

21. An atomizer according to claim 17 wherein the first channel is shaped so that  
the thin film is cylindrically shaped.  
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22. An atomizer for forming droplets, the atomizer comprising:  
a first channel through which a liquid may flow, the channel comprising a  
constriction for spreading the liquid into a thin film in the channel; and  
a second channel through which an atomizing gas may flow, the second  
25 channel being positioned so that the atomizing gas impinges the liquid thin film at a right angle to  
produce droplets.

23. An atomizer according to claim 22 wherein the constriction has a diameter  
less than 0.020 in.  
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24. An atomizer according to claim 22 wherein the constriction has a diameter

less than 0.005 in.

25. An atomizer according to claim 22 wherein the first channel is shaped so that the thin film is cylindrically shaped.

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26. A spray drying system for forming a pharmaceutical formulation, the system comprising:

an atomizer, the atomizer comprising a first channel through which a liquid may flow, the channel comprising a constriction for spreading the liquid into a thin film in the channel, the atomizer further comprising a second channel through which an atomizing gas may flow, the second channel being positioned so that the atomizing gas impinges the liquid thin film to produce droplets;

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a drying chamber to dry the droplets; and  
a collector to collect particles dried in the chamber.

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